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Controlling Hazardous Wastes Research Summary

JRB Associates, Inc.
McLean, VA

Prepared for

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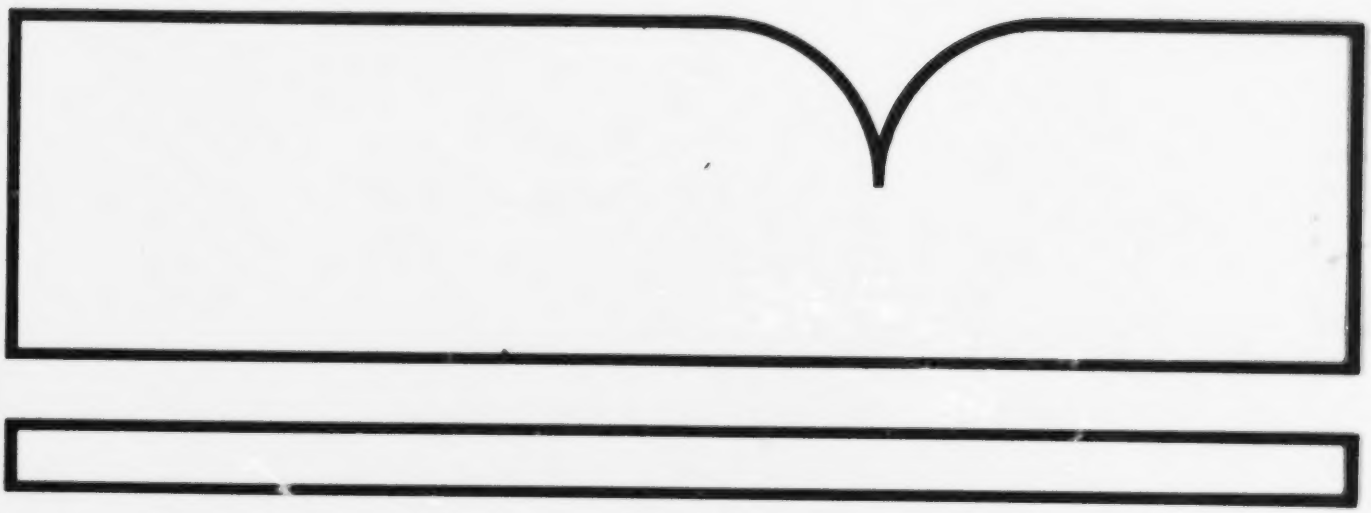

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Office of Research and Development

EPA

Research Summary

Controlling Hazardous Wastes

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An estimated 90 percent of the hazardous waste generated in the United States is disposed of by environmentally unsound methods. In the wake of numerous well-publicized hazardous waste disposal mishaps, we now know that such practices pose a serious threat to our health and the environment. Public concern has been heightened by the widespread belief that recent events at the Love Canal in New York and the Valley of the Drums in Kentucky represent but a tip of the hazardous waste iceberg.

The Federal government initially responded to the critical hazardous waste problem in 1976 with the enactment of the Resource Conservation and Recovery Act (RCRA). More recently, the Administration has proposed the Oil, Hazardous Substances and Hazardous Waste Response, Liability and Compensation Act—a comprehensive "Superfund" program to assure the proper management of hazardous wastes through the use of economic incentives. Successful implementation of both RCRA and the Superfund legislation requires major research and development efforts to assure that the Agency's regulatory and enforcement activities can be adequately carried out. With this in mind, the Office of Research and Development has embarked on an extensive research program to develop technologies to identify and control the disposal or destruction of hazardous wastes.

As you read this summary of our research, I think it will become evident that hazardous wastes control is not simply a matter of technology development. Public attitudes and practices play an essential role in hazardous wastes cleanup. I encourage you to look upon controlling hazardous wastes not just as an industrial and governmental problem, but also as a personal one.

Stephen J. Gage
Assistant Administrator
for Research and Development

This brochure is one of a series providing a brief description of major areas of the Environmental Protection Agency's research and development program. Additional copies may be obtained by writing to:

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16. ABSTRACT

This brochure contains a concise description of EPA's hazardous wastes research program. The 3-part discussion focuses on hazardous wastes identification, emergency response, and long-term control technologies.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
	Hazardous wastes Waste identification Waste Monitoring Waste Dumping Dumping Toxic Waste	

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hazardous wastes generation

It is expected that between 30 and 40 million metric tons of hazardous wastes will be generated in the United States in 1980. This corresponds to between 66 and 88 billion pounds, or 300 to 400 pounds of wastes per person. By the year 2000, annual hazardous wastes generation may double. Disposal of this tremendous quantity of waste is a matter of great public concern in the wake of recent revelations of negligent dumping practices at numerous locations throughout the country.

In the past, hazardous wastes have been disposed of with little or no attention paid to site location, safety measures, or maintenance of records. This has led to numerous instances of contamination that have severely damaged the environment and threatened human health. For example, in early 1978, the drinking water of Toone, Tennessee, was severely contaminated by chemicals leaching from a nearby landfill. Later the same year, four dumpsites containing more than 19,000 indiscriminately discarded drums of hazardous wastes were discovered near Louisville, Kentucky. These sites later became collectively known as the Valley of the Drums.

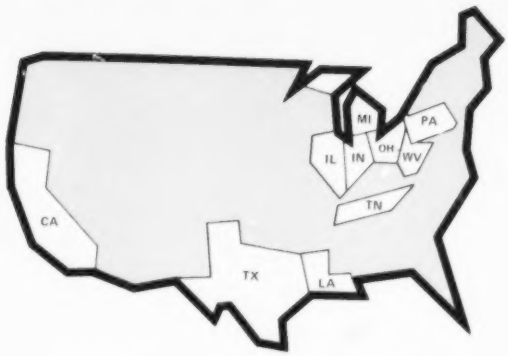
love canal

Perhaps the most dramatic example of inadequate disposal of hazardous chemical wastes occurred near Niagara Falls, New York. More than 200 families living along an abandoned waste disposal site, known as Love Canal, had to permanently evacuate their homes when toxic chemicals seeped up through the ground and into their basements. The more than 20,000 metric tons of chemical wastes in Love Canal include an estimated 300 different chemicals, 100 of which have been identified to date. New York State officials estimate that possibly 10 percent of the chemicals in the dumpsite may be mutagens, teratogens, or carcinogens. Benzene, a known carcinogen, as well as 11 other suspected carcinogens have been identified. One of the wastes at the site, trichlorophenol, contains dioxin, a chemical that animal tests have shown to be 100 times as deadly as strychnine. Investigators report there may be as much as 500 pounds of dioxin buried in Niagara County.

The production of hazardous wastes is concentrated both by industry and by location. Seventeen major types of industries are responsible for about 85 percent of all hazardous wastes. About two-thirds of this total is generated in ten States.

waste sites

The EPA has identified 151 hazardous waste sites in the United States that pose a threat to human health or the



10 STATES THAT PRODUCE 65% OF ALL HAZARDOUS WASTE.

environment. The list of sites is under continuous review and is periodically updated. One study performed for the EPA's Office of Solid Waste indicates that there may be as many as 32,000 hazardous waste dumpsites throughout the United States, 1,200 to 2,000 of which may present significant health or environmental problems. Other estimates set the total number of dumpsites at 50,000. Few of these disposal sites have been inventoried, and the risks posed by them are unknown. In addition, there is a wide spectrum of unauthorized and potentially harmful disposal of hazardous wastes through indiscriminant "midnight dumping."

resource conservation and recovery act

The Resource Conservation and Recovery Act (RCRA) of 1976 was the first comprehensive Federal legislation to deal with the hazardous wastes issue. Under RCRA's "imminent hazard" provision, the EPA may file suit against a company to force it to change the way it handles, stores, treats, and disposes of hazardous wastes, if these practices present an imminent danger to human health or the environment. However, for the litigation process to be successful, the company must be solvent. In the case of many abandoned sites, even if the company can be identified, it may have long since gone out of business.

To deal with the cleanup cost and liability problems not handled by RCRA, the Administration has proposed a $1.6 billion fund to be established over a 4-year period. If enacted the Oil, Hazardous Substances and Hazardous Waste Response, Liability and Compensation Act, more commonly known as the "Superfund" bill, will encourage more careful handling of hazardous materials through provisions allowing for the recovery of cleanup costs from those responsible for a spill or dumping incident.

management approach

A phased approach to wastes management has been developed by EPA, in response to the mandates of the Resource Conservation and Recovery Act:

1. To reduce the generation of wastes at the source by improving production processes, improving durability and product life, and other techniques.
2. To remove both materials and energy from wastes to maximize recycling and resource recovery.
3. To ensure that those wastes that cannot be eliminated or recovered are stored, transported, treated, and disposed of by procedures that guarantee public health and safety and the integrity of the environment.

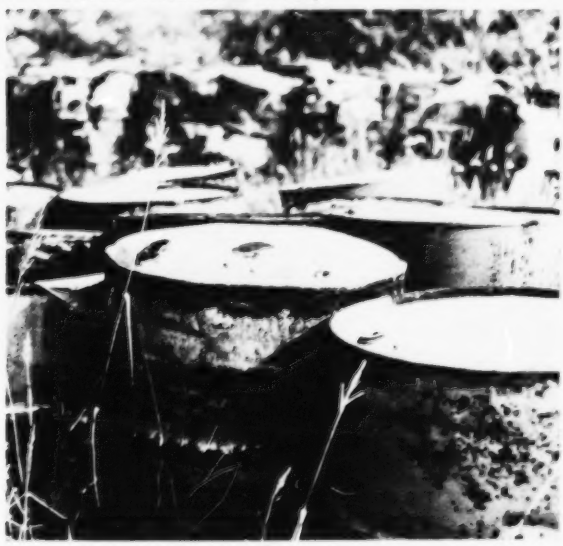
The first two elements of this stragegy are key goals of the Agency's long-range management and research program. The immediate threat posed by improper wastes disposal have made the third element the major short-range priority.

ORD research

To support the Agency's short-range hazardous wastes management initiatives, the Office of Research and Development (ORD) has undertaken a three-part research program:

- identification (including measurement, monitoring, and quality assurance)
- remedial action and emergency response
- long-term controls.

ORD is complimenting this three-part control program with a risk assessment program to provide the Agency with data to judge the threat of disposal sites to human health and the environment. The hazardous wastes risk assessment program will be the subject of a future Research Summary.



identification

definition

More than 4 billion metric tons of solid wastes are annually generated in the United States. The 30 to 40 million metric tons of hazardous wastes represents roughly one one-hundredth of this total. The fact that hazardous and nonhazardous wastes are frequently generated and disposed of in conjunction with one another presents major identification and segregation problems.

The Resource Conservation and Recovery Act (RCRA) defines a waste as hazardous if "because of its quantity, concentration, or physical, chemical, or infectious characteristics it: (a) causes or significantly contributes to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or (b) poses a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of or otherwise managed."

The EPA considers a waste to be hazardous if it possesses any of four characteristics: ignitability, corrosiveness, reactivity, or toxicity.

An initial step in the identification of hazardous wastes is to understand the industrial processes generating the wastes.

For more than 5 years, the Office of Research and Development has gathered information on the organic chemical, inorganic chemical, pesticide, organic dye and pigment, and other industries. Data on the industrial organic and inorganic chemical industries has been computerized to facilitate updating and information retrieval. The data base is frequently used to determine the sources of hazardous wastes by providing information on proper sampling and analysis procedures.

Developing accurate testing methods and procedures to identify hazardous wastes is difficult due to the wide assortment of sources, sites, and chemical characteristics of these wastes. The Office of Research and Development has a three-part hazardous wastes identification program underway to support the promulgation and enforcement of EPA regulations under RCRA: measurement, monitoring, and quality assurance.

measurement

Proper control and disposal of hazardous wastes depends on practical and precise sampling and analysis procedures. The Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-Las Vegas) is conducting a program to evaluate proposed sampling, analysis, and classification procedures.

The Las Vegas lab is evaluating two techniques for obtaining waste samples. One technique is for use at waste ponds, pits, and lagoons, and the other is for sampling containers such as drums, tanks, and tank cars. The extraction procedures involve various means of separating potentially harmful components from waste, thus permitting assessments as to whether a particular waste is hazardous.

A primary step in the control of any hazardous waste is identification of the individual waste components. EPA's Environmental Research Laboratory in Athens, Georgia (ERL-Athens), is developing guidelines for detecting organic compounds in water that will serve as a tool for analyzing water samples containing unidentified pollutants. These guidelines will be especially useful in the identification of leachates and water samples from disposal sites.

Gas chromatography is the principal analytical means of identifying volatile organic compounds, which comprise 10 to 20 percent of the total number of organic compounds found in water. Another technique, high pressure liquid chromatography (HPLC), can be used to identify a wider range of the less volatile organics. Researchers are combining the use of gas chromatography and HPLC to identify a large number of toxic organic compounds. ORD plans to develop analytical procedures for the detection of toxic organic chemicals in soils and sediments in the near future.

The proper disposal of hazardous wastes has often been hampered in the past by the lack of a standard procedure to verify the contents of drums and trucks containing wastes, and the lack of understanding or concern by many landfill operators regarding the dangerous chemical reactions that can result when particular wastes are combined. Deception

and disregard in these two areas have resulted in uncontrolled reactions leading to serious environmental harm and to human death. Recognizing that information dissemination is an initial step toward a solution to these problems, ORD's Municipal Environmental Research Laboratory in Cincinnati, Ohio (MERL-Cincinnati), is developing a series of manuals intended for use by persons responsible for sampling, handling, and disposing of hazardous wastes. Manuals on effective sampling procedures and waste compatibility will aid in identifying specific wastes and in preventing combinations of dangerous chemicals. The draft booklet on chemical compatibility describing the families of wastes that can be safely mixed, is presently being used with success by landfill operators in California. A test kit to determine the stability of waste combinations in landfills is also currently under development.

monitoring

EPA is mandated by RCRA to monitor hazardous wastes generation, storage, transport, treatment, and disposal. The Office of Research and Development is improving monitoring procedures and protocols to develop a more systematic approach to fulfill the Agency's responsibilities. The Environmental Monitoring Systems Laboratory in Las Vegas has management and research responsibility in this area.

safety and hazard guide

Individuals involved in the monitoring and cleanup of hazardous materials are often exposed to highly toxic chemicals. To help assure the safety of workers involved in these activities, ORD's Las Vegas Laboratory recently completed a two-part Hazardous Materials Spills Monitoring Safety Handbook and Chemical Hazard Guide. The 2-year preparation effort required the extensive review of hazardous chemical spill histories to determine the chemicals involved, their identifying characteristics, the degree and nature of the hazards they posed, and the frequency of occurrence of specific chemicals in spills.

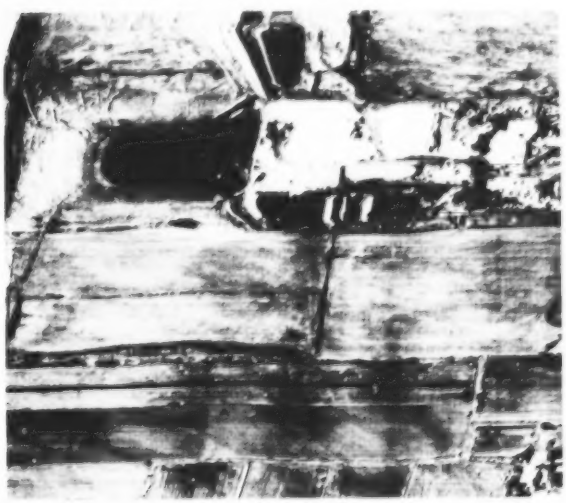
The Hazard Guide portion of the handbook contains information on the chemical nature, degree of hazard, and exposure and safety precautions to be taken for more than 650 chemical compounds. The Safety Handbook portion suggests proven first aid measures to be taken in the case of accidents or exposure to hazardous chemicals. The suggested measures are not intended to replace professional medical attention, but rather they appear so that personnel who are exposed to a toxic substance receive adequate immediate lifesaving assistance. Information on obtaining the Handbook and Guide is located in the "For Further Information" section at the end of this publication.

aerial surveillance

EMSL-Las Vegas has primary responsibility for aerial detection of hazardous wastes disposal sites and for surveillance of cleanup operations. The Las Vegas lab is monitoring sites in the western regions, while its Vint Hill Field Station in Warrenton, Virginia, is responsible for surveillance in the East.

At the request of EPA regional offices and the Office of Solid Waste in Washington, DC, many abandoned dumpsites were photographed in the last 2 years in several states including Pennsylvania, Ohio, Arkansas, Nevada, and New York. These aerial images serve as an important source of information on disposal operations and possible environmental degradation, and are frequently used in litigation. Historical photographs, often dating back as many as 40 years, offer EPA a record of activities at a site. Present-day aerial imagery can indicate burial sites, stored drums, and damaged vegetation, as well as aid in assessing a site's terrain and drainage patterns.

Special photographic techniques using thermal infrared scanners and color infrared film, can provide more specific information. Infrared scanners detect heat radiated from a



site and record it as white on black-and-white film. For example, the ponds in the photograph below appear to be white due to the heat resulting from chemical reactions of hazardous wastes.

Also, heat radiating from the ground may indicate the presence of reactive chemicals in buried waste. Thermal infrared scanning techniques were used extensively at Love Canal.

Color infrared film can be used to photograph chlorophyll, and thus proves useful in documenting damage to plant life not normally detected by conventional films or by the naked eye.

Aerial photography can also be used to monitor cleanup efforts and to locate new disposal sites. Techniques for analyzing terrain and drainage can be applied to finding more secure locations for hazardous wastes storage.

Several of the Office of Research and Development's laboratories are involved in the development of guidelines for all phases of wastes management where monitoring is required. The Environmental Monitoring and Support Laboratory in Cincinnati, Ohio (EMSL-Cincinnati), has responsibility for water monitoring, while the Environmental Monitoring Systems Laboratory in Research Triangle Park, North Carolina (EMSL-RTP), is responsible for air monitoring. Past studies have focused on the movement of toxic substances in water. ORD is now undertaking studies on the movement of volatile toxic or hazardous substances in air. Strong odors and damage to vegetation around waste sites are indications that air emissions are a potential health and environmental hazard. Studies are underway to explore the problem of air emissions from hazardous waste sites and to identify air monitoring methods and protocols.

quality assurance

EPA is developing a quality assurance program to guarantee the reliability of data obtained through the measurement and monitoring programs. The program will not only ensure that decision-makers are provided accurate data, but it will also protect the data—and decisions based on it—from legal challenges. Quality assurance defines the limits of measurement and monitoring data in terms of sensitivity, reproducibility, detection limits, and accuracy.

The program will also assure that proper analytical procedures are followed, and that personnel who conduct research are properly trained and equipped. The Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, is developing minimum laboratory standards and practices, and is coordinating the existing quality assurance efforts at other ORD laboratories. In addition, it is developing reference materials in conjunction with the National Bureau of Standards to calibrate instruments and to evaluate and compare the data developed at other laboratories.

remedial action and emergency response

The Office of Research and Development is supporting the Agency's regulatory activities in response to the many uncontrolled hazardous waste sites throughout the United States. EPA recently established a National Headquarters Waste Site Enforcement Task Force to deal with the uncontrolled site program. The Agency is presently identifying and, where possible, rectifying waste problems through various legal and contractual processes. ORD is playing an important role in this program through its past efforts in the development of technology and equipment to control oil spills. Various Office of Research and Development laboratories are expanding their hazardous wastes technology development activities to assist the Task Force.

ORD's Municipal Environmental Research Laboratory in Cincinnati, Ohio (MERL-Cincinnati), has the lead role for research and development related to hazardous waste environmental emergencies. Through a program at its Oil and Hazardous Materials Spills Branch in Edison, New Jersey, MERL-Cincinnati is developing prototype equipment and experimental techniques for controlling wastes. Ultimately, the program will encourage commercialization of these new techniques. However, when commercial equipment is unavailable, responses are made to actual emergencies at the request of EPA regional offices. Recent emergency assistance has been provided at a PCB spill in Philadelphia, Pennsylvania; a pesticide spill on Long Island, New York; and at Love Canal in Niagara Falls, New York.

Field evaluations of remedial technologies are currently underway at dumpsites to determine their effectiveness, durability, and cost. This research will result in a series of engineering manuals to assist officials in the selection and operation of proven cleanup technologies. Special attention will be given to the cost effectiveness of systems and the proper coordination of emergency response and long-term control actions.

emergency response unit

MERL-Cincinnati coordinates projects on a number of new approaches to hazardous materials control. Once development and testing in the laboratory have been completed, these techniques are turned over to the Edison lab's Environmental Emergency Response Unit (EERU) for field testing. Upon completion of field testing, prototype equipment is maintained under the EERU program to respond to cleanup emergencies. The program enables the EPA to evaluate and demonstrate various cleanup technologies on

spills and dumpsites throughout the country, thereby encouraging private firms to manufacture or use similar equipment. Several prototype cleanup devices are now ready for field use, and some are commercially available. At least two private companies currently offer the equivalent of the mobile physical/chemical treatment system, the most frequently used EERU equipment. This system, mounted on a semi-trailer and capable of treating 100 gallons of contaminated water per minute, is designed to remove and concentrate hazardous chemicals by a variety of methods. It contains equipment for coagulating and settling suspended solids, precipitating heavy metals, filtering very fine particles, and adsorbing contaminants using granular-activated carbon.

Two mobile laboratories are also ready for use. One is equipped to perform rapid screening tests at sites where a quick assessment of an emergency situation is needed. The other lab can provide rapid, precise chemical analyses of water, soil, and waste at a cleanup site. Both mobile labs can be used when a conventional laboratory is too distant from a site to provide the quick identification of contaminants necessary for determining proper action. By monitoring water samples during cleanup operations, the laboratories can also aid in determining when site treatment has been sufficient. Several private firms now have rapid screening labs, and at least one company has built an analytical lab for use at spill sites.

Another prototype system for which testing has been completed is the Spill Alarm Trailer, used to monitor the level of contaminants in streams. The system consists of five detection instruments and can operate unattended for up to 2 weeks. If any of the five instruments detects contamination above a predetermined level, the system automatically takes

a sample and sends an alarm to the EERU. While originally designed to detect spills that may otherwise have gone unreported, the system is now being used with success to detect changes in the flow of contaminants from illegal dumpsites.

Other EERU equipment includes a powdered carbon physical/chemical treatment unit and a stream diversion system. The trailer-mounted treatment unit has a 50 gallon-per-minute capacity and operates similarly to the larger granular-activated carbon system. The stream diversion system is used where an insoluble hazardous material lies in a stream bed. Pumps and pipes reroute the stream to expose the material, which is then removed by excavation equipment. The system is capable of diverting small streams up to 3,000 feet and larger ones up to 1,000 feet.

soil treatment system

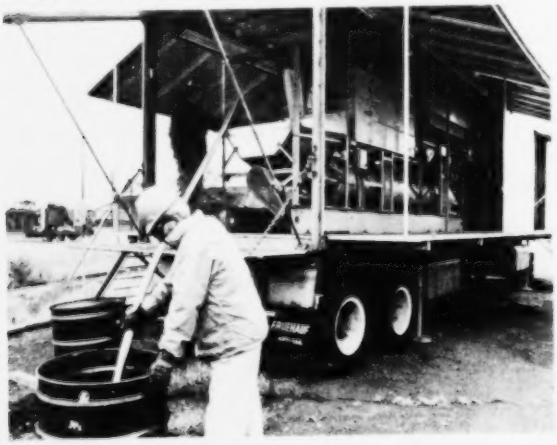
Designed to treat soils contaminated as a result of spills or leaching from inactive dumpsites, the soils treatment system contains the tanks, pumps, and hose to allow the use of several high-pressure injection techniques. One of the treatment methods involves injecting a grout material such as cement or bentonite (a clay that absorbs water to expand to several times its normal size) to form a grout curtain in the soil. The construction industry has used grout curtains for some time to consolidate soils and divert groundwater. In its application to hazardous wastes, this curtain reduces the spread of a contaminant by isolating a section of soil. The procedure begins by pumping the grout through a pipe driven into the soil. The grout permeates the soil surrounding the end of the pipe, forming a spherical shape about 3 to 6 feet in diameter. The pipe is then withdrawn far enough so that the next injection of grout creates a sphere on top of the first. This procedure is repeated to form a column. A curtain results when a number of grout columns merge.

ORD's mobile soil grouting unit, pictured below, is being used for demonstration purposes at various locations across the country.

Other control techniques include injecting chemicals to detoxify contaminants, introducing nutrient or biological material to accelerate biodegradation, and simply injecting water to wash contaminants from the soil.

mobile carbon regenerator

Adsorption, a process in which the molecules of one substance adhere to the surface of another, provides one important means of removing dissolved organic hazardous material from water. When contaminated water is passed through granular-activated carbon, the pollutant clings to the granules. With use, however, the carbon becomes progressively "full," losing its adsorptive capability. A method for regenerating activated carbon, and disposing of its toxic adsorbants, is being prepared for demonstration by MERL-Cincinnati at its Edison lab. This technology, which restores at least 90 percent of the carbon's adsorptive capacity, improves on commercial regenerators, many of which are not built to handle carbon that has adsorbed certain hazardous materials. The trailer-mounted reactivator will operate onsite, complementing the mobile physical/chemical treatment system or similar units, thereby avoiding the risk of transporting spent, toxic carbon. The heart of the process is a rotating kiln that heats the carbon at 1800°F for 20 minutes and releases the adsorbed contaminants as vapor. The vapor then passes into a combustion chamber where it is decomposed. Air pollution control equipment detoxifies any exhaust gases. Once the carbon is cooled with water, it is ready for reuse.



mobile incinerator

High-temperature incineration offers a viable means for detoxifying or destroying a number of long-lived hazardous substances. It can also effectively separate contaminants from soil and other materials. The process has the advantage of reducing contaminants to simple, nontoxic compounds that can be safely disposed in landfills. The Edison laboratory is nearing completion of a mobile incinerator that will destroy such hazardous compounds as PCB, the pesticides Kepone and malathion, and TCDD, a persistent pesticide component. The system, designed to operate on the

actual site of a spill, is mounted on three semi-trailers and equipped with a rotating combustion chamber, a stationary combustion chamber, and air pollution control equipment. The incinerator can handle 9,000 pounds of contaminated soil or 75 gallons of liquid per hour. Solid wastes are first shredded to facilitate burning, while liquids and fluid sludges can be pumped directly into the rotating combustion chamber. Air pollution control equipment cleans the cooled exhaust gases before venting them to the outside air.

soil surface sealing

MERL-Cincinnati's Edison branch is also testing several low-cost, portable methods of sealing soil surfaces to prevent groundwater contamination from spilled hazardous chemicals. The most promising technique involves the use of a flexible plastic sheet that can provide protection in several ways. Placed over a spilled material, the sheet can keep off rain that might otherwise cause the chemical to spread. It can also be placed in such a way that a flowing hazardous material spreads onto it and not into the soil.

A more sophisticated soil surface sealing technique has proven feasible on smooth surfaces such as sand, but is less effective on wet or rough areas, such as damp grass or rocky ground. Research is continuing on spray techniques that use melted or even dissolved plastics to form a cover sheet.

foams

In addition to the danger of soil and water contamination, some hazardous spills and abandoned dumpsites threaten the environment because of toxic air pollution resulting from chemical evaporation. The Office of Research and Development is nearing completion of a study on the use of foams to minimize vaporization from accidental spills of volatile liquids. The primary objective of the project is to match hazardous chemicals with the most effective foam.

Researchers recently finished testing six types of foam used by fire departments, ranging from a high expansion formula that creates a layer 18 to 24 inches deep, to five kinds of low expansion foam that are usually used in 2-inch layers. Many foams of both high and low expansion proved effective on nonpolar liquids (those that do not dissolve in water, including many petroleum products). Against polar compounds, which are water-soluble and include strong acids and many pesticides, only an alcohol-type low expansion foam worked well. Researchers plan to extend their tests to newly marketed foams devised specifically for hazardous chemical spills.

long-term controls

The development of technologies to control hazardous wastes over the long term is critical to EPA's mission to guarantee the protection of public health and the environment from adverse effects of hazardous wastes. The search for effective technologies is complicated by the fact that different wastes have different storage, treatment, and disposal requirements.

Only 10 percent of the 30 to 40 million metric tons of hazardous wastes generated annually is believed to be managed in accordance with upcoming EPA regulations. Another 10 percent is incinerated without proper controls, and 80 percent is disposed of in nonsecure landfills, lagoons, or ponds.

In the near future, the greatest percentage of hazardous wastes will initially be disposed of by landfilling. As RCRA is implemented, however, these facilities will be upgraded and new secure sites will be constructed. As a result, land disposal costs will rise to as much as three times their current level. To save money, more generators will direct their wastes to incinerators and make use of chemical and biological treatment. In addition, certain wastes will be eliminated through recovery and reuse processes.

Over the long term, waste destruction, reduction at the source, and reuse are better control solutions than land disposal or containment. However, the engineered landfill is likely to remain the common method of disposal until these alternatives are improved. Incineration will probably be the most common alternative in the next 5 to 10 years. It has the potential both to destroy wastes, and to recover energy from them. It has not, however, been routinely used to achieve the levels of waste destruction that will be required in forthcoming regulations. The Office of Research and Development is looking for ways to improve destruction efficiencies through improved incinerator design and maintenance.

Because of the large number of hazardous waste streams resulting from numerous industrial processes, it is impossible for ORD to develop control technologies for every waste generating process. Fortunately, pending RCRA regulations will give waste generators a substantial economic incentive to conduct and apply their own research and development efforts where testing of specific technology options is necessary. ORD is therefore focusing on a limited number of priority waste streams, industrial and commercial waste sources, and waste control problems. EPA is placing special

emphasis on cost sharing, cooperative research efforts in areas of mutual interest.

The Office of Research and Development's program for developing long-term hazardous wastes control technologies is divided into four major areas of effort: containment, thermal decomposition, treatment, and centralized management.

containment

Containment research is directed towards developing technologies for hazardous wastes landfilling, land treatment, storage, surface impoundment, fixation, and stabilization.

liners

ORD is developing landfill and surface liner systems to prevent the leaching of wastes from disposal sites. Methods are being developed to determine which liners are best suited for various types of wastes. Individual liners are being evaluated for durability, impermeability, and chemical compatibility with various hazardous wastes. Manuals are then developed that compare the predicted performance of various liner designs.

ORD is developing methods for predicting the composition, rate of generation, and total quantity of leachates from hazardous wastes land disposal facilities. On the basis of this information a technique will be developed to predict pollutant movement from specific disposal sites. Data resulting from this research will be very useful in designing disposal facilities, predicting landfill effectiveness and lifetime, and for predicting any pollutant release.

encapsulation of drums

At dumpsites where drums of hazardous chemicals lie carelessly exposed to the weather, a serious threat is posed by the eventual deterioration of the drums and subsequent leaking of chemicals. A study of techniques for encapsulating drums, both damaged and intact, is underway at MERL-Cincinnati. In laboratory tests, a miniature, preformed polyethylene jacket reinforced with fiberglass has proven to be a strong, flexible casing that is also impervious to chemical leaching. The combination of polyethylene and fiberglass stands up exceptionally well in compression, impact, and puncture tests, which represent stresses more severe than would normally be encountered. Laboratory tests have also shown that leakage from badly damaged drums can be prevented by wrapping a fiberglass casing around a drum and then spraying or brushing on a plastic resin. The resin dries in air, offering an advantage over the preformed casing, which requires special equipment to fuse the fiberglass and polyethylene.

Research is also proceeding on a full-size polyethylene container that can be fuse welded to hold hazardous wastes or to seal drums. Cost estimates are similar to those for current methods of sealing metal containers; however, researchers expect the performance of this technique to be greatly superior. The concept holds promise not only for the burial of wastes, but also for their transport and storage.

disposal pit for pesticides

MERL-Cincinnati has nearly completed work on an inexpensive method enabling farmers to safely dispose of pesticides left over from crop applications. Researchers have successfully tested a relatively simple technique using a small

concrete pit lined with soil and limestone. Pesticides deposited in the pit are absorbed by the soil and limestone allowing microorganisms to break down the chemical's biodegradable components. Various insecticides and herbicides can be deposited together without problems of reactivity. In addition, the pit does not require emptying since the amount of chemicals deposited is small in relation to the pit's size. A lid kept over the structure minimizes evaporation.

MERL-Cincinnati is beginning research on another disposal pit in conjunction with the U.S. Department of Agriculture. The new design will employ a transparent cover that allows solar radiation to speed biodegradation processes.

volatile organic emissions

The release of volatile organic chemical vapors into the atmosphere from disposal facilities is not well understood. ORD is actively working with EPA's Office of Air Quality Planning and Standards (OAQPS) to determine the magnitude of the problem. If the emissions prove to be substantial, additional studies will be undertaken to investigate, predict, and control them.

deep-well injection

For years, industry has employed a technique for injecting liquid waste—much of it toxic or radioactive—into porous rock deep in the earth. There is debate, however, on whether such deep-well injections are safe. Opponents argue that these wastes, injected under extreme pressure, can flow laterally through geologic strata into poorly constructed or unplugged deep wells and then rise to contaminate subsurface water supplies. These fears were partly

borne out in 1968 when two accidents further raised concerns about deep-well practices. In Erie, Pennsylvania, a well receiving 150,000 gallons-a-day of paper processing byproducts abruptly spouted a 20-foot geyser of wastes. During the 3 weeks spent capping the well, some 4 million gallons of injected wastes poured out. In the same year in Denver, Colorado, the U.S. Army disposed of its nerve gas supplies through deep-well injection. The gas apparently caused an unknown geologic fault to slip, and a series of small earthquakes shook the city. When injections were halted, the earthquakes stopped.

The EPA has since examined some of the technical aspects of deep-well injection, particularly ways of measuring and predicting the extent of dangerous pressure buildup in the strata surrounding wells. The Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, recently completed a study of this problem, in support of proposed regulations on deep-well injection. Researchers studied the pressure data on operating wells and devised over 30 equations for estimating such increases.

containment manuals

Several hazardous waste containment manuals are being prepared by MERL-Cincinnati covering all engineering and environmental aspects of hazardous wastes disposal in landfills and surface impoundments. The manuals will provide wastes disposal operators necessary technical information to comply with Resource Conservation and Recovery Act regulations.

thermal decomposition

High priority is being given to hazardous wastes thermal decomposition research to support the development of incineration regulations. ORD researchers recently identified the combustion requirements for destroying Kepone sludge in Hopewell, Virginia, and current efforts are directed at establishing the conditions necessary for incinerating other hazardous wastes. Two related research projects are underway at ORD's Industrial Environmental Research Laboratory in Cincinnati, Ohio (IERL-Cincinnati). The first employs a complex laboratory system to analyze the products of incineration over a range of combustion conditions. The results of this research will be used in a second field study in which the incineration of 10 hazardous wastes, including PCB, will be carefully monitored. The tests will be run in a commercially available incinerator modified to include advanced air pollution control devices: an afterburner to destroy residual organics, a wet scrubber to further purify the gases emitted, and a filter to remove particulates.

ORD is also investigating the thermal combustion of wastes aboard incinerator ships. The emissions from burning chlorinated organic waste aboard a Dutch vessel have been carefully documented, and EPA regulatory offices plan to use this data in setting domestic and international guidelines on incineration at sea. One advantage of this method of incineration is that the process takes place far from populated areas. Stack scrubbers, an additional expense for incineration on land, are not used aboard these ships; the traces of chemicals that escape are thought to be absorbed by the ocean, and thus greatly diluted. In 1977, the U.S. Air Force made use of the Vulcanus, a Dutch incinerator ship to

successfully burn more than 10,000 metric tons of Agent Orange, a herbicide used in Vietnam which is frequently contaminated with dioxin. The demonstrated feasibility of incinerator ships from other nations, plus stricter EPA regulation of hazardous wastes disposal, may eventually encourage private U.S. firms to enter the field.

In a related project, IERL-RTP is exploring the possibility of incinerating hazardous wastes on abandoned offshore oil drilling platforms. The feasibility and environmental effects of such an operation are presently being examined. As with incineration aboard ships, an oil drilling platform off the coast would be well away from population centers. For ORD's purposes of research and demonstration, a platform may offer the additional advantage of flexibility in testing various types of incineration technology.

The Office of Research and Development recently purchased a rotary-kiln incinerator and modified it to permit sophisticated monitoring and control of test waste incinerations. Over the next 2 years detailed tests will be conducted on each of the major classes of hazardous wastes. In a companion program, a highly sophisticated laboratory thermal decomposition analytical system (TDAS) is being used to learn more about the optimal combustion conditions for various wastes, and to study the formation of potentially hazardous combustion by-products. ORD's incineration research facilities are available for quick response testing of wastes as a service to EPA regulatory and enforcement offices nationwide.

model incinerator

IERL-Cincinnati is designing a one-twentieth scale model of a full-sized industrial wastes incinerator to aid in determining the efficiency of various incinerator designs. The model will be flexible enough to allow major changes in structure for the purpose of modeling more than one incinerator. Although the unit is not planned as a mobile incinerator, it can be moved to various sites for testing.

cement kilns

An alternative to incineration is the use of existing high-temperature industrial processes for hazardous wastes destruction. Cement kilns have been used at several sites throughout the world to decompose highly toxic substances such as PCB's. Researchers at IERL-Cincinnati are exploring the use of these kilns to destroy various chlorinated organic wastes.

industrial boilers

Another type of thermal decomposition process involves burning hazardous wastes in standard industrial boilers. This process offers several benefits, among them the ability to utilize some of the thousands of industrial boilers already in existence, the possibility of energy recovery, and the elimination of the need to transport the wastes to distant disposal sites. Tests are being conducted in various types of industrial furnaces to determine the specific boiler modifications that must be made if the wastes are to be safely destroyed. ORD researchers are currently looking at optimal oxygen levels during combustion, the use of afterburners to break down certain pollutants, and the potential need for scrubbers.

treatment

The third long-term hazardous wastes control research area involves the development of treatment technologies in three major areas: preprocessing or predisposal, destruction or detoxification, and upgrading existing wastes treatment and disposal facilities. Preprocessing or predisposal treatment involves the partial detoxification of wastes prior to disposal, storage, or further processing. Destruction or detoxification processes render wastes completely nonhazardous. Finally, upgrading existing wastes treatment and disposal facilities involves the development of treatment techniques that can be retrofitted to improve facility safety or performance. Technologies currently being used in wastewater treatment and industrial processing are being modified and improved to handle hazardous wastes.

Particular emphasis is being placed on developing technologies to treat highly toxic organic and inorganic wastes. In addition, ORD is looking closely at the waste treatment technology needs of those industry groups that will be most affected by Resource Conservation and Recovery Act regulations. Research is focusing on the treatment of landfill leachates, abandoned lagoon contents, and the design of centralized hazardous wastes treatment and disposal facilities. Such techniques as carbon adsorption, solvent extraction, chemical coagulation, sedimentation, distillation, and biological treatment are being tested on selected hazardous waste streams. Once the tests are completed, profiles on performance, cost, energy efficiency, capacity, and waste compatibility will be developed. Guidelines will then be distributed to industry, waste management facility operators, and other local, State, and Federal officials to assist them in the selection of efficient hazardous wastes treatment technologies.

centralized treatment

Centralized treatment of hazardous wastes is possible where industries producing similar types of waste are located in close enough proximity to allow the economical transportation of waste materials. Hazardous wastes can either be treated at one centralized location or individual plants can exchange wastes and treat those for which they are best technologically suited. The Federal Republic of Germany has successfully used this concept of industrial wastes treatment for many years, and the Office of Research and Development is examining its feasibility in the United States.

The Cincinnati Industrial Environmental Research Laboratory has undertaken a study of the U.S. electroplating industry, and its potential for centralized waste treatment. The city of Cleveland has been chosen for advanced study due to its high concentration of electroplating plants. All technical and economic aspects of centralized treatment are being examined to determine the concept's feasibility in this area. ORD is optimistic that centralized treatment will not only be useful to the Cleveland electroplating industry, but also to numerous other industries throughout the country. Over the long term, ORD plans to prepare centralized treatment design and operation manuals to help State and local waste management authorities implement the concept in their region.

individual research projects

industrial environmental research laboratory — cincinnati, ohio

Selected research projects performed by or through the various ORD laboratories or offices are listed below.

- Detection of Insoluble Hazardous Materials on River Bottoms
- Soil Surface Sealing to Halt Groundwater Intrusion by Spills of Hazardous Materials
- "In Situ" Treatment of Hazardous Spills in Large Watercourses
- Development/Demonstration of Mobile, Field-Use Activated Carbon Regeneration System with Recovery/Detoxification of Hazardous Material Spills
- Design, Construction, and Demonstration of a Mobile Field-Use System for the Detoxification/Incineration of Residuals from Oil and Hazardous Material Spills
- Special Emergency Spill Response Activities
- Biodegradation Processes for Disposal of Spilled Hazardous Materials
- Ultimate Disposal Using Liquid Metal Reaction or Glass Encapsulation
- State-of-the-Art Survey and Methods/Materials Matrix Assessment of Ultimate Disposal Techniques for Spilled Hazardous Materials
- Restoring Hazardous Spill-Damaged Areas: Technique Identification/Assessment
- Evaluation/Development of Foams for Mitigating Air Pollution from Hazardous Spills
- Parametric Modification of Spill Factors Affecting Air Pollution
- Mobile System for Washing Hazardous Wastes from Soils
- Mobile System for In Situ Treatment/Grouting of Contaminated Soils
- Bromination Process for Disposal of Spilled Hazardous Materials
- Identification of Technology for Control and Cleanup of Environmental Emergencies Involving High-Strength Hazardous Wastes

municipal environmental research laboratory — cincinnati, ohio	• Evaluation of Hazardous Waste Storing, Sampling, Analysis, and Compatibility • Toxicity Testing Methods, Development, and Validation • Predicting Movement of Selected Metals in Soils; Application to Disposal Problems • Laboratory and Field Evaluation of Chemically Stabilized Sludges • Development of Safe Methods for Disposal of Excess Pesticides Used by Farmers and Applicators • Development of Pilot Scale Microwave Plasma Detoxification Process for Hazardous Wastes • Laboratory and Field Evaluation of Processes and Materials for Encapsulating Containers Holding Hazardous Wastes • Air Pollution Sampling and Monitoring at Hazardous Waste Facilities • Evaluate and Develop Techniques to Concentrate Hazardous Constituents of Liquid Hazardous Waste Streams • Development and Demonstration of Methods to Control Inorganic Chemical Wastes Discharged to the Municipal Sector • Remedial Action at a Hazardous Waste Disposal Site • Remedial Action at a Surface Impoundment Site • Remedial Action Assistance to the LaBounty Landfill Site • Remedial Action at the LiPari Landfill Site • Identifying Best Practical Technology for Remedial Action at a Municipal Landfill Site
environmental monitoring systems laboratory — las vegas, nevada	• Evaluation of Sampling Procedures in the Proposed Hazardous Waste Regulations • Evaluation of the Extraction Procedure and Associated Analytical Methods in the Proposed Hazardous Waste Regulations • Initiation of a Hazardous Waste Monitoring Quality Assurance Program • Characterization of Hazardous Wastes Identified in the Proposed Hazardous Waste Regulations
environmental research laboratory — athens, georgia	• Development of a Master Analytical Scheme for Organics in Water • Sorbtion Processes in Soils and Water • Prediction of Microbial Transformation of Toxic Substances in Natural Waters and Sediments

robert s. kerr environmental research laboratory — ada, oklahoma

- Bioorganic Indicators of Groundwater Pollution
- Movement and Fate of Viruses and Organic Pollutants in Groundwater During the Land Treatment of Wastewater
- Fate of Organic Pollutants in a Wastewater Land Treatment System Using Lagoon Impoundment and Spray Irrigation
- Behavior of Organic Pollutants in Simulated High-Rate Infiltration Systems
- Fate of Organic Compounds in Aquifers
- Direct Injection of Reclaimed Water for Groundwater Recharge

industrial environmental research laboratory — research triangle park, north carolina

- Feasibility Study: Offshore Incineration Platform - Phase I, Conceptual Design
- At Sea Incineration - Sampling, Analysis, and Environmental Assessment

for further information

publications

- EPA Research Outlook. February 1980. EPA-600/9-80-006. 224 pages.

  A description of EPA's plans for future environmental research.

- EPA Research Highlights. January 1980. EPA-600/9-80-005. 100 pages.

  Highlights of the EPA research and development program accomplishments of 1979.

other research summaries

- EPA Research Summary: Controlling Nitrogen Oxides. February 1980. EPA-600/8-80-004. 24 pages.
- EPA Research Summary: Acid Rain. October 1979. EPA-600/8-79-028. 24 pages.
- EPA Research Summary: Oil Spills. February 1979. EPA-600/8-79-007. 16 pages.

  Information on the availability of these publications may be obtained by writing to:

  Publications
  Center for Environmental Research Information
  US EPA
  Cincinnati, OH 45268

  or by calling (513) 684-7562

technical reports and manuals

- Guidance Manual for Minimizing Pollution From Waste Disposal Sites. August 1978. EPA-600/2-78-142. 95 pages. (PB-286 905, $6.00)
- Land Disposal of Hazardous Wastes. Proceedings of Annual Research Symposium (4th), held at San Antonio, Texas on March 6, 7, and 8, 1978. EPA-600/9-78-016. 438 pages. (PB-286 956, $14.00)
- Manual for the Control of Hazardous Material Spills. Volume 1: Spill Assessment and Water Treatment Techniques. November 1977. EPA-600/2-77-227. 490 pages. (PB-276 734, $15.00)
- State-of-the-Art Report: Pesticide Disposal Research. September 1978. EPA-600/2-78-183. 247 pages. (PB-284 716, $14.00)

- Hazardous Materials Spill Monitoring: Safety Handbook and Chemical Hazard Guide. January 1979.

  Part A. EPA-600/4-79-008A. 49 pages. (PB-295 853, $6.00)

  Part B. Chemical Data. EPA-600/4-79-008B. 674 pages. (PB-295 854, $19.00)

Technical reports or manuals may be obtained by writing to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

or by calling (703) 557-4650

question or comments

The Office of Research and Development invites you to address any questions or comments regarding the EPA Hazardous Waste Control Research Program to the appropriate individuals listed below:

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